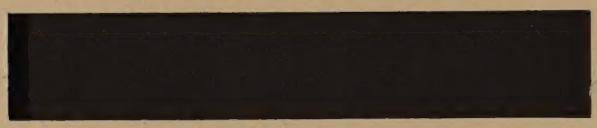
MCL INC
LA GRANGE ILL

OPERATING MANUAL
MODEL 1014-60V
TWT AMPLIFIER

INSTRUCTION MANUAL

MCL/INC
DESIGNERS AND MANUFACTURERS OF RF COMPONENTS AND SYSTEMS
TEN NORTH BEACH · LA GRANGE ILLINOIS 60525 · 312-354-4350



INSTRUMENT SHOP

OPERATING MANUAL
MODEL 10460V
TWT AMPLIFIER

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TITLE:

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T101
1005-009

S101

L.V.

X

LV

DS101

X

115V
230V

(K) SEE NOTE 3

F101 6A
F102 3A
F103 5A
F104 3A

(E) S105

B101

TWT BLWR

BLUE

WHITE

RED

C105
1μf
370VAC

T102
1005-006

CR101

R101
39K

C101
.0047

R105
22 MΩ

C102
2μF

R110
100Ω

R111
150Ω

R102
100Ω

V101
4X150A

C103
0.5μF

T103
1005-007

R103
470Ω

R10
1KΩ

X1

X2

S106
NOO
THERM SWITCH
NC

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL
A	ORIGINAL JSK	2-24-73	RJB
B	ADD R110 & R111, CHG WIRING OF C103	6/6/73	
C	DS102 WAS DS 103, DS104 WAS DS102, ADDED C105 NB	6/27/73	
D	RELOCATED TP501 JSK	7/8/73	
E	3A WAS 2.5A	2-20-74	
F	REVISED	3-15-74	
G	CORRECTED PER 3538 ECO	7-24-74	
H	JUMPER Q203 COLLECTOR AROUND J201 BUSS + DELETED GRID FROM J203 DS	4/11/75	
J	ADDED NOTES 1+2. REVISED R217 FOR CERTAIN MODELS	8/28/75	3047 3057 3420 4070
K	ADDED NOTE 3, F101-F104 CHANGE FOR 10460V DS	8/28/75	4063

J102

CR301

F301

Q301 2N3055

J301 BRN (HTR.-)

R301 120Ω

C302 10μf

Q303 2N5142

Q302 2N5782

CR303 1N5343

4

R302 200Ω

CR302 1N4737

C301 1000μf

R303 470Ω

J302 YEL.

R304 .33Ω

C

(HTR+)

HEATER ASSY. 1005-008-301

TB101

HTR/CATH

HTR

TB101

C501 47PF MAYBE .0047μf, @ 6KV

R512 R511 R510 R509 R508 R507 R506 R505 R504 R503 R502 R501

A

R517 R518 R519 R520 R521 R522 R523

V

SEE NOTE 1 C502 .0047μf

CATH

TB101

ANODE

V102

TP501

M

HEAT

COLL.

TB101

K501

N

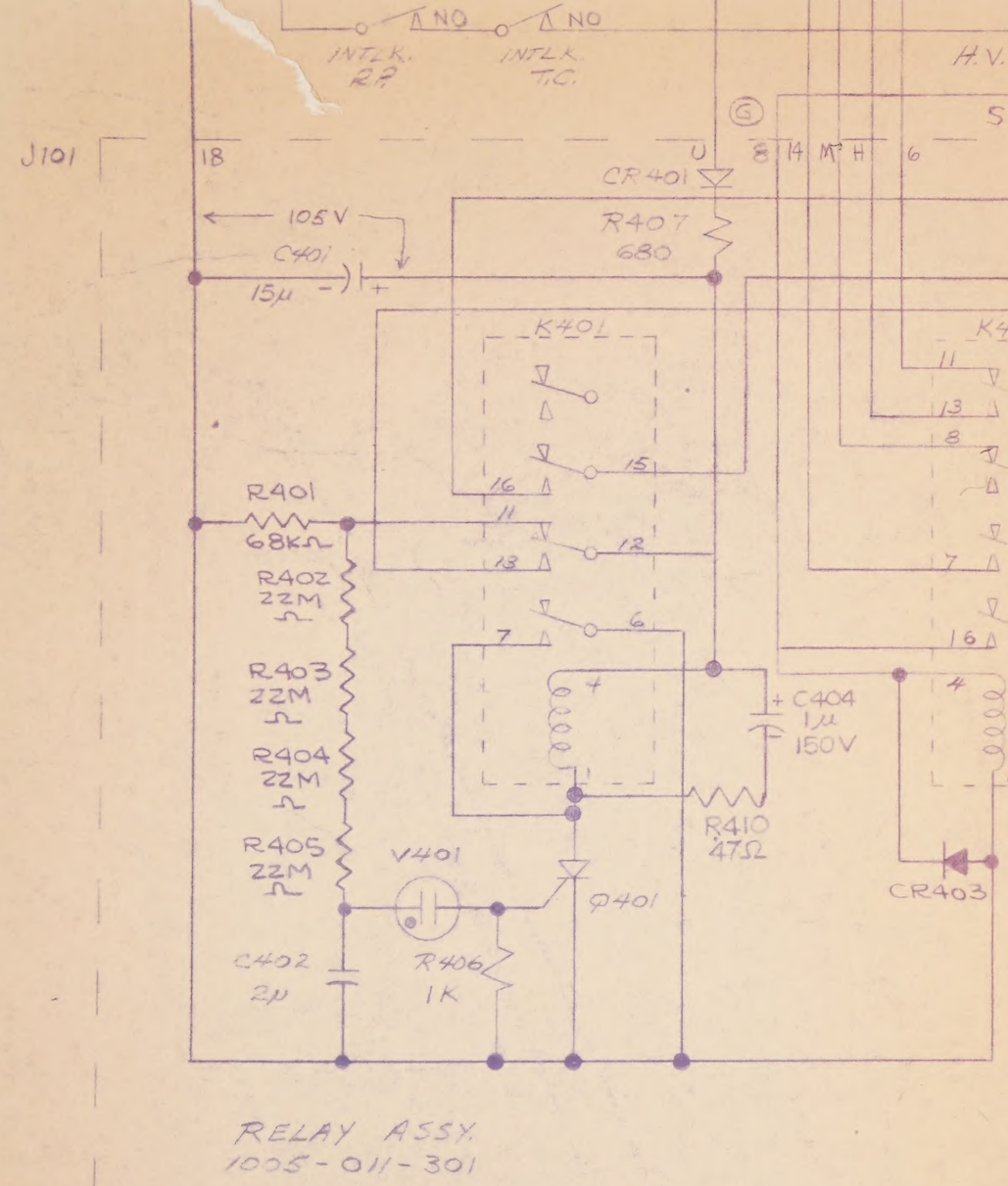
P

K

S

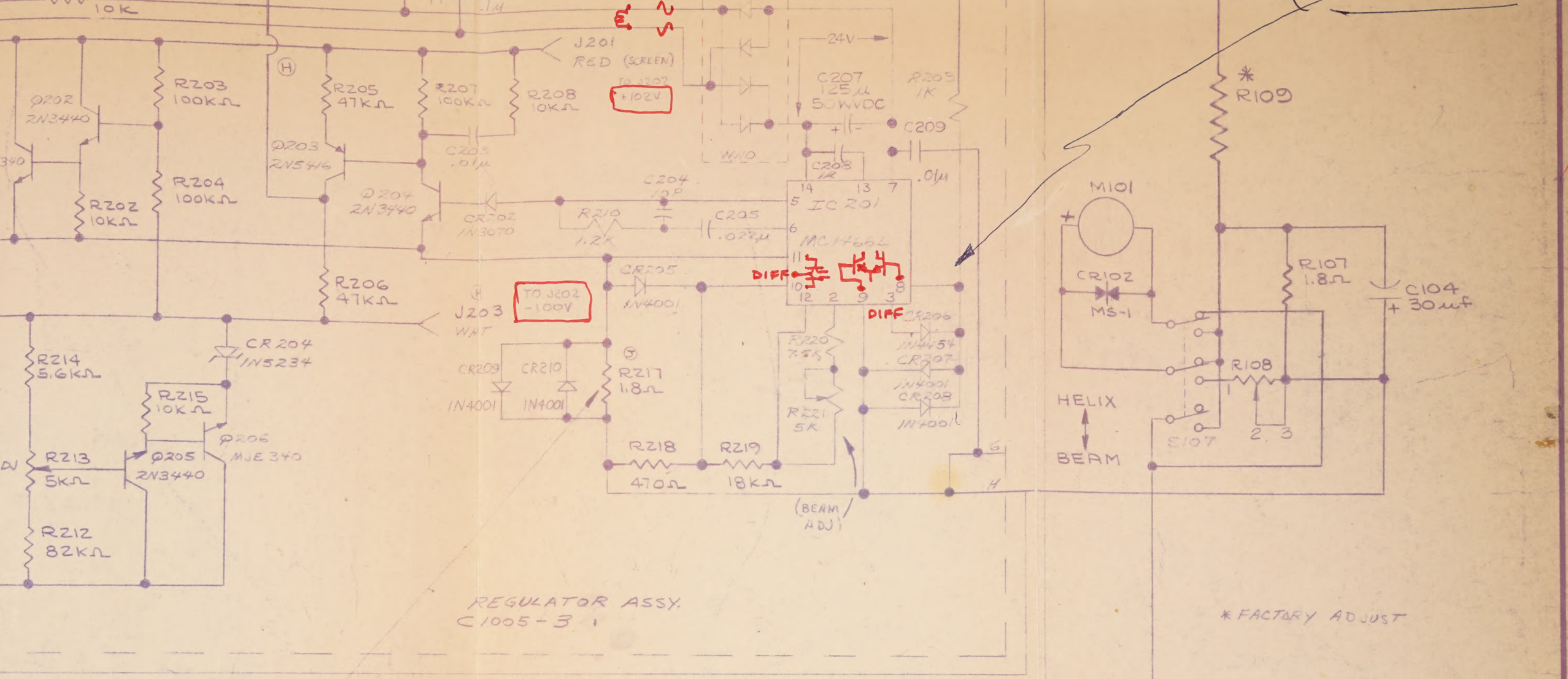
GAIN R106

E = 4000 TOT KATHODE



RELAY ASSY.
1005-011-301

NOTE:
1. C502 D
104584, 10
2. WA = MG
3. ON MOD
F102-5



REGULATOR ASSY.
C1005-3

*FACTORY ADJUST

Ω, 1/2W, 5% CARBON
ELS 10450V
10451V
10452V

D ON) MODELS 10457V
+10460V.
μ
460V-F101-10 AMP.
103-8AMP. F104-5AMP.

ITEM	PART NO.	QTY.	DESCRIPTION	MAT'L.	MAT'L. SPEC.

LIST OF MATERIAL

DO NOT SCALE:

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES FRACTIONAL ±
DECIMAL ±
ANGULAR ±

MATERIAL:
SPEC:
FINISH:
SPEC.

DRAWN	JSIC	2-26-73	
CHECKER			
MECH. ENGR.			
ELEC. ENGR.	RJB	4-4-73	
PROJ. ENGR.			
CHIEF ENGR.			

SCHEMATIC
20 WATT TWT
FOR USE WITH
VARIAN TUBES

MCL MICROWAVE CAVITY LABORATORIES
MICROWAVE CAVITY LABORATORIES
LAGRANGE, ILLINOIS

32D1362

SCALE: WEIGHT ACT. CALC. SHEET OF

NEXT ASS'Y	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY. REQ'D.	

10450V THRU 10460V REF.

1.0 GENERAL

The purpose of this document is to outline the operating procedures for the MCL 20 Watt TWT Amplifier series.

THIS DOCUMENT IS NOT INTENDED AS A REPAIR MANUAL DUE TO THE EXTREMELY HAZARDOUS VOLTAGES INVOLVED.

Schematic Diagram 32D1362 or 32D1363 is used as a reference for this manual.

2.0 PRECAUTIONS

2.1 Observe AC input power requirements as outlined in Section 3.0.

2.2 Note the maximum load VSWR indicated on the front panel of the TWT Amplifier. The load VSWR is different for various tube types used and therefore is not included in this manual. Never allow the H.V. to be on if the RF input or output c onnections are unterminated.

2.3 To prolong tube life, do not allow the amplifier to remain in Standby for periods greater than 1/2 hour. It is best to keep the unit in transmit or shut off completely.

2.4 CAUTION: Lethal voltages are present during operation. Use only insulated tools in making adjustments with the high voltage on.

Dangerous voltages are also present during Standby conditions. Observe extreme caution in making any internal adjustment.

3.0 ELECTRICAL SPECIFICATIONS

3.1 AC input 115V/230V ±10%, 60 Hz, 6A max.

3.2 Input and output impedance 50 ohm. VSWR dependent upon the tube type used.

3.3 Helix, Collector and Fil P.S. are regulated.

3.4 Frequency RF power input and output is dependent upon model number and tube type used.

4.0 THEORY OF OPERATION

4.1 AC Power

The AC input of 115V or 230V, as determined by the back panel selector switch S105, is applied to J108. Fuses F101 and F102 located on the rear panel, protect the unit from AC overload. The AC control function is provided by PC board 1005-011-305, connected to J106. When the Main On switch S101 is depressed, blower B101 and Heater Regulator Assy. 1005-011-301 are activated. AC is applied to a time-delay circuit which in approximately 3 minutes will place the unit in a standby condition. This allows ample time to heat the cathode of the TWT. After standby operation is achieved, the HV On switch S104 may be activated. To revert to a standby condition, depress the Standby switch S102. Depressing the Main On switch will remove AC power from the unit.

4.2 HV-DC Regulator

The output of the T102 is rectified by CR101, filtered by C102, and is regulated by PC Assembly 1005-003-301 and the pass tube V101.

4.3 Heater Regulator

The PC card 1005-008-301 is a heater regulator and provides a stable DC voltage to the heater of the TWT tube.
NOTE: THIS SUPPLY IS AT A NEGATIVE VOLTAGE OF 1400 TO 4000 VOLTS DEPENDENT UPON THE TWT TUBE USED. DO NOT ADJUST THE HEATER VOLTAGE WHILE THE UNIT IS IN A HV "ON" CONDITION.

4.4 Cathode "Turn-On"

Upon initial application of the High Voltage, the anode is clamped to the cathode through K501. When the cathode potential reaches 70 to 90% of its operating value, K501 will open and return the anode to its normal potential, allowing beam current to flow. This sequencing is provided to prevent the TWT from de-focusing and drawing excessive current.
NOTE: HV IS PRESENT ON THIS BOARD DURING OPERATION

4.5 Resistor Assembly

The resistor assembly 1005-010 provides an error signal to the voltage regulator sense input to provide the HV regulation and also controls the turn-on level of relay K501.
NOTE: HV IS PRESENT ON THE BOARD DURING OPERATION $R = \frac{E_K \text{ TWT}}{.9\text{mA}}$

4.6 Over-Current Protection

Relay board 1005-011-301 provides Helix over-current protection. If the Helix current rises above the set value, relay K403 will open the interlock circuit and the unit will revert to a standby condition.

4.7 Temperature Interlocks

A thermal interlock is provided on the TWT tube heat sink and will open the interlock line if an air restriction or failure occurs. The tube overheats due to excessive current or the ambient inlet air temperature reaches a level that will not properly cool the tube. When the condition is rectified and the tube cools to a temperature below the limit of the sensing switch, HV operation can again be achieved.

4.8 Chassis Interlock

When the top cover is removed, S108 will open, causing a Standby condition and preventing the HV from being applied. This switch

TITLE:

4.8 Chassis Interlock (con't)

can be defeated for servicing by pulling up on the actuating pin until a click is heard and the pin remains up. S104 may now be depressed and the HV will be activated. USE EXTREME CAUTION IN MAKING INTERNAL MEASUREMENTS OR ADJUSTMENTS.

4.9 Metering

A panel meter M101 is provided to measure Helix and beam (cathode) current. The meter reads directly for Helix current and readings must be multiplied by 10 for beam current measurement. S107 on the panel selects the function of the meter. The normal values of current will differ with various tube types and is noted in the test data.

5.0 GAIN CONTROL

5.1 The front panel gain control (R106) will provide approximately 6 db of control over the TWT.

6.0 RF TESTING

Refer to the block diagram in paragraph 6.0 for the test connections. This will vary to some extent dependent upon the frequency range and available equipment. Apply an input signal through the input directional coupler to the system. The power level is monitored by the power meter connected to the forward port of the directional coupler. Output power is monitored through the directional coupler on the output line of the TWTA. Measure output power and gain at the rated power of the TWT (20W) vs. frequency, and record on the data sheets in paragraph 9.0. Record also the Helix current under drive. Special tests will be made as required per individual unit.

7.0 RF TESTING BLOCK DIAGRAM

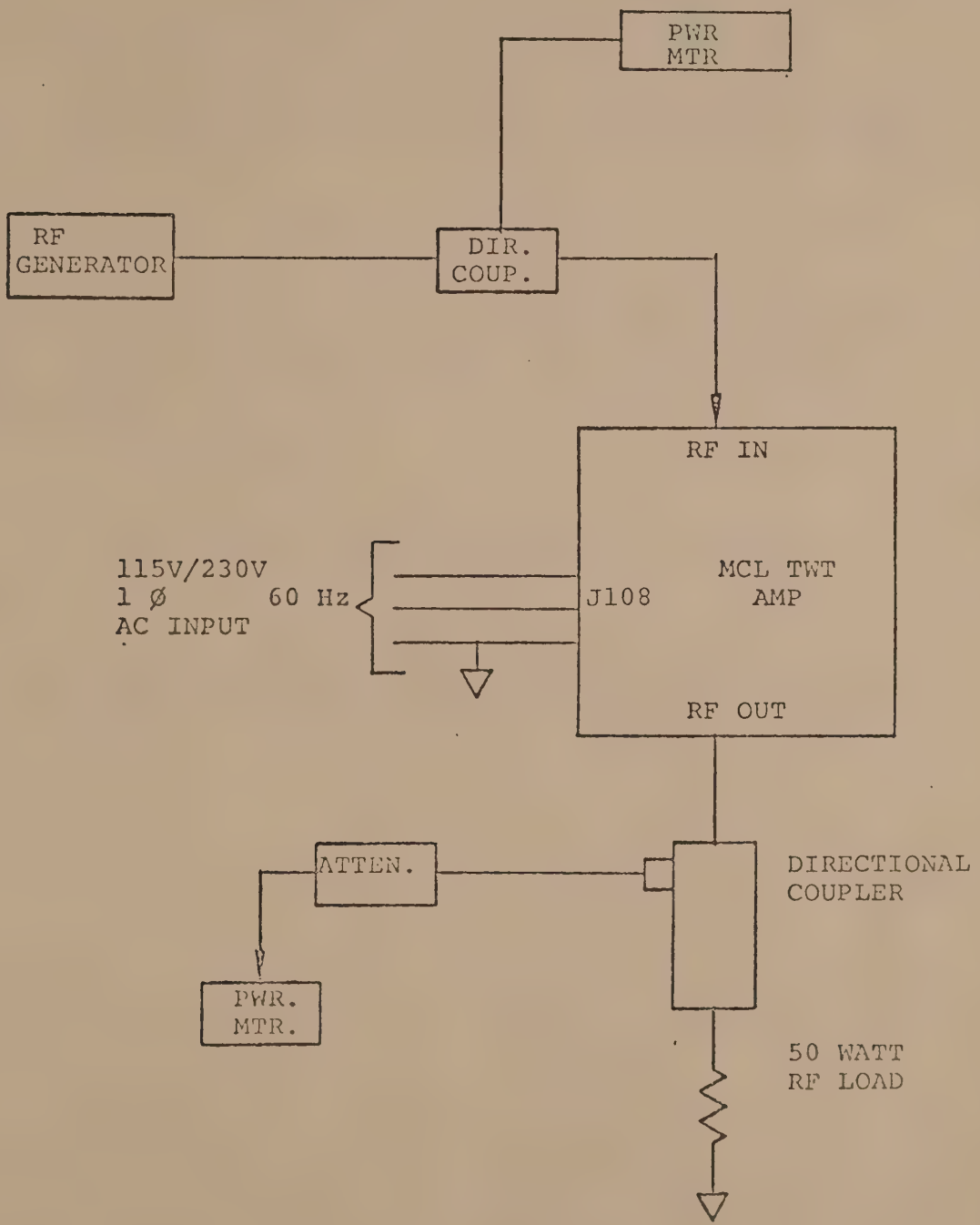
See Sheet 7 of 9.

8.0 SERVICE

During the warranty period, the unit should be returned to MCL for service. Unauthorized repairs will void the warranty. After this period expires, maintainance, calibration, and repair may be done at the customers facility or the unit may be returned to MCL for such service and will be billed to the customer. It is recommended that TWT tube replacement be effected at MCL facilities.

TITLE:

7.0 RF TESTING BLOCK DIAGRAM



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9.0 WARRANTY

Under recommended use and service, all MCL products are warranted against defects in material and workmanship for nine (9) months from the date of original shipment. Material returned after 90 days of the original shipping date will be repaired on a pro-rata basis. MCL's obligation is limited to repairing or replacing at our plant , products which prove to be defective during the warranty period. Tubes. transistors, and other solid state devices are covered by the respective manufacturer's warranty which applies from the date of shipment of the unit from MCL.

MCL is not liable for consequential damage resulting from the use of MCL equipment.

There will be no charge for repair of units under warranty except non-authorized shipping charges. In the event that responsibility for repair lies with the customer, customer will be charged for the cost of re-testing, repair and shipment. Estimates of charges will be supplied before work begins.

CLAIM FOR DAMAGE IN SHIPMENT:

Your unit should be inspected and tested as soon as it is received. Claims for damage should be filed with carrier.

SHIPPING:

Upon receipt of shipping instructions, forward the unit to the destination indicated. For non-warranty service, the unit must be shipped prepaid.

9.1 VSWR PROTECTION OPTION

All standard MCL travelling wave tube amplifiers are protected against high VSWR terminations when equiped with the high VSWR protection option. This option consists of a three port circulator and associated low reflection termination. The circulator is connected between the TWT output connector and the amplifier output. High VSWR reflections from a poor amplifier termination are then absorbed by the protection circuit termination. Although the protection circuit components are rated for 100% reflections at the maximum amplifier power level, long periods of operation without a termination or with a short or open are not recommended.

10.0 TEST DATA

CATHODE VOLTAGE	4000	V
ANODE VOLTAGE	0	V @ max. gain
HEATER VOLTAGE	6.35	V
WARM-UP TIME	140	SEC
QUIESCENT HELIX CURRENT	1.3	MA
QUIESCENT CATHODE CURRENT	87	MA
DRIVEN HELIX CURRENT	2.4	MA
AC LINE CURRENT	6.5	A @ 120 VAC

FREQUENCY MHz	RF INPUT MILLIWATTS	RF OUTPUT WATTS	GAIN DB
12.4	0.02	20	60
13.0	0.03	20	58
13.5	0.03	20	58
14.0	0.03	20	58
14.5	0.04	20	57
15.0	0.06	20	55
15.5	0.10	20	53.0
16.0	0.13	20	51.7
16.5	0.14	20	51.5
17.0	0.25	20	49.0
17.5	0.36	20	47.4
18.0	0.40	20	47.4

TRAVELING WAVE TUBE
TUBE TYPE NO. VTU-6191H1
SERIAL NO. 4 J 8 DATE 7-25-75

TWT ACCEPTANCE TEST DATA

CUSTOMER:

OPERATING CONDITIONS[1]

TWT TEST	SYMBOL	MIN	MAX	RESULT	UNITS
Heater Voltage[2]	Ef	6.0	6.6	6.3	V
Heater Current	If	---	1.4	1.0	A
Helix Voltage (Label Value	Ew	3850	4050	4000	Vdc
Helix Current (1) No Drive	Iw	---	10.0	1.4	mAdc
Helix Current (2) Sat Drive at 12.4 GHz	Iw	---	10.0	2.3	mAdc
Collector Voltage	Eb	2500	Ew	2500	V
Cathode Current	Ik	---	100	87	mAdc
Anode Voltage	Ec	-200	Ew	Ew	Vdc
Anode Current	Ic	---	1.0	0.03	mAdc
Power Output: Saturation 12.4-18.0 GHz	Po	43	---	See Table	dBm
Gain at (43) dBm (20 W) Output	G	45	---	See Table	dB

1. Voltages are with respect to cathode.
2. If dc heater voltage is used on this tube, the heater must be negative with respect to the heater-cathode.

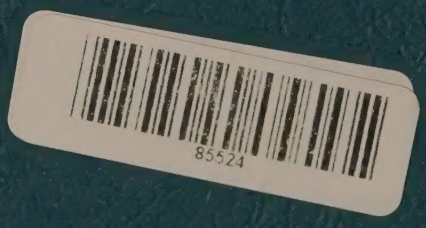
Freq. (GHz)	Sat Po (dBm)	Gain At 43 dBm (dB)
12.4	45.8	59.6
13.0	45.5	58.4
13.5	45.8	58.4
14.0	45.4	57.5
14.5	45.4	56.6
15.0	45.2	54.7
15.5	45.3	54.4
16.0	45.2	53.0
16.5	45.0	50.9
17.0	45.0	49.9
17.5	44.7	47.7
18.0	44.2	45.1

LEAD CONNECTIONS

Cathode	-	Green
Heater Cathode	-	White
Heater	-	Yellow
Anode	-	Red
Collector	-	Gray
Helix	-	Brown
Base	-	Brown

TUBE TYPE	OUTLINE DRAWING NO.
VTU-6191H1	50883 -

TESTED BY: [signature] DATE: 7-25-75 VARIAN QA: [signature] (QA 01) 7-25-75



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